Practicing Change: Curriculum Adaptation and Teacher Narrative in the Context of Mathematics Education Reform

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ABSTRACT

The use of reform-based curricula is one possible avenue for the widespread implementation of mathematics education reform. In this article, we present two urban elementary teachers' *models of curriculum use* that describe how each teacher used a reform-oriented mathematics curriculum. In particular, we examine when and how the teachers made adaptations to the curriculum. We find that each teacher had a distinctive pattern of adaptation when using the curriculum. Furthermore, these patterns were related to three key aspects of the teachers' own experiences with mathematics: their early memories of learning mathematics, their current perceptions of themselves as mathematics learners, and their mathematical interactions with family members. Implications for curriculum design and implementation are discussed.

There have been many efforts to implement mathematics education reform during the last 15 years. Some of these efforts have been quite successful at changing practices in selected classrooms and schools, but few, if any, have been able to change classroom practices on a large scale (Ball, 2001). One avenue, an approach with a long tradition, for bringing about

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widespread reform is the development of new standards-based curricula. Yet, recent research has shown that to effect change, curricula need to not only support student learning, but also directly address teachers' learning and teaching needs (Ball & Cohen, 1996; Davis & Krajcik, 2005).

To make reform curricula more effective in promoting large-scale change in mathematics instruction, we first need to understand in detail how and why teachers, particularly experienced teachers, use reform curricula[1] to guide and inform their teaching practices. Teacher change does not occur simply because there are curriculum materials in the classroom that contain information and ideas that are new to the teacher. Instead, changes in teachers' instructional practices are the result of particular interactions between teachers and curricular materials around specific subject matter and pedagogical content (Ball, 1997; Remillard, 2000; Remillard & Bryans, 2004). Just as reformers talk about the critical role of students in their own learning of mathematical content, teachers must be considered as critical agents in their own learning from and implementation of curriculum (Craig, 2001). Hence, understanding what teachers, as both learners and teachers of mathematics, bring to this interaction is at least as important as understanding what is contained in the curriculum.

Prior research has investigated the effects of teachers' subject matter knowledge, pedagogical content knowledge, and beliefs, among other factors, on their implementation of reform curricula (e.g., Educational Evaluation and Policy Analysis [EEPA], 1990; Thompson, 1992). Often, this research has compared the implementation practices of teachers with little knowledge to those of teachers with deep, flexible knowledge (Ball, 1991). Here, we take another approach and consider the impact of teachers' identities as learners and teachers of mathematics on their implementation and, in particular, their adaptation of a reform curriculum. Our claim is that teachers' narrative identities as learners and teachers of mathematics frame the ways in which they use and adapt a reform-oriented mathematics curriculum.

Curriculum adaptation is clearly only one among many aspects of teachers' practices in the context of reform. Furthermore, the relationships between teachers and curricula have often been filled with significant tensions and challenges (Ben-Peretz, 1990; Remillard, 1999, 2000). Nonetheless, we feel that exploring teachers' patterns of adaptation when using a new curriculum can provide interesting insights into the ways in which teachers incorporate reform principles into their instructional practices. Furthermore, since curricula have been and continue to be a widespread vehicle for the promotion of the messages of reform, teachers' uses of curricula, and the ways in which they alter or adapt curriculum materials seem to be an important area for research.

In this paper, we present a study of two urban elementary teachers implementing Children's Math Worlds (CMW) (Fuson, 2000), a reform-oriented mathematics curriculum. We focus on only two teachers in this

paper to understand, at a detailed level, the narrative identities and patterns of adaptation for the teachers—a level of description and analysis that would not be possible with a larger number of teachers. Following descriptions of the reform context, theoretical framework, and methodology, we introduce the two teachers' mathematics narratives and then describe the role that adaptation played in each of the teachers' implementations of CMW. In particular, we show that the two teachers had very different approaches to adapting the curriculum materials to meet their needs and the perceived needs of their students. Furthermore, we claim that these different adaptation styles can be better understood in light of key differences between the two teachers' narratives about themselves as learners and teachers of mathematics.

THE REFORM CONTEXT

The reform program that served as the context for this study is CMW, an elementary-level mathematics curriculum developed at Northwestern University. Beth and Linda,[2] the two teachers described in this paper, were two of several teachers in a large urban school district who were piloting the curriculum materials. Both of the teachers chose to pilot the materials voluntarily as a result of discussions with the curriculum developers, and not at the mandate of school or district administrators. The voluntary nature of their participation, combined with the curriculum's origin in a research university rather than the school, district, or state or federal government, are important to keep in mind when considering the results of this study. While such an arrangement is not unusual (e.g., Schifter, 1996), we imagine that the experiences of the teachers might have been quite different had the curriculum been a district-developed program that they were required to use.

In terms of content, CMW was aligned with many of the ideals of the National Council of Teachers of Mathematics (NCTM) Principles and Standards (2000) and other reform documents. Most important for this study, CMW explicitly addressed the first four of six principles laid out by NCTM—a focus on *equity* and excellence for all students, a coherent *curriculum*, and *teaching* and *learning* activities that build on and challenge students' prior knowledge (NCTM, 2000). At the same time, it was designed to blend aspects of both traditional and reform-oriented instructional methods to build an "equity pedagogy" (Fuson et al., 2000) in urban classrooms. CMW sought to promote student understanding of mathematics through the use of meaningful verbal, situational, and visual representations and the promotion of classroom discourse around problem-solving and students' multiple solution methods (Hufferd-Ackles, 1999). The focus of the curriculum was on using children's drawings and strategies to help them develop efficient and generalizable solution methods for a variety of

mathematical problems. To facilitate this development, the curriculum materials, particularly the teachers' guide, stressed the use of math-talk (Hufferd-Ackles, Fuson, & Sherin, 2004), or high levels of questioning and explaining among teacher and students, within the mathematics classroom.

Based on interviews with the teachers and observations of their early teaching practices, it is clear that using the curriculum represented a major change, or reform, in the teachers' learning and teaching practices. For Beth, the most significant difference between her "old" and "new" ways of teaching mathematics was the emphasis on student strategies and building on student thinking. Prior to this experience, Beth was a teacher who was known for and who prided herself on her "control" of her students—both behaviorally and intellectually. Using this curriculum encouraged her to cede some intellectual control to her students. Linda, on the other hand, had spent most of her career as a kindergarten teacher and had rarely used a formal mathematics program or curriculum. Thus, for her, the major change involved in using CMW was the idea of following a set of written materials that comprised a coherent program, rather than a collection of unrelated activities, which might most accurately describe the way in which she understood her previous mathematics instruction.

THEORETICAL FRAMEWORK

In this study, we filled dual roles as both professional developers—working with teachers to help them implement the curriculum and change their teaching practices—and researchers seeking to understand the process of reform implementation from the teachers' perspectives. As part of this process, we began to notice that, often, our greatest insights into teachers' experiences of the curriculum—what they understood and did not understand, what they noticed and did not notice, the ways in which they interacted with and related to the curriculum—came from chance meetings in the hallways or late-night phone calls in which teachers related these experiences to us in the form of anecdotes, or stories. Furthermore, we also noticed that within these stories, teachers often compared and contrasted their earlier experiences learning or teaching mathematics, and often learning or teaching particular mathematical content (e.g., multi-digit subtraction with regrouping), with their current experiences with the curriculum. As a result of these interactions, we came to believe that understanding teachers' identities and prior experiences as learners and teachers of mathematics was key to both facilitating and understanding their implementation of the reform curriculum. The study presented here is one outcome of our efforts to systematically capture and analyze these identities and experiences, while remaining close to the narrative, story-based form through which the teachers had already been communicating with us.

Thus, this study is framed by prior research in two areas. First, we draw from studies of the role of identity and, in particular, narrative identity, in the reform implementation process, and second, from studies of teachers' uses and adaptations of curricula. We believe that bringing these two literatures together will generate new understandings of the impact of teachers' identities on their day-to-day teaching practices in the context of mathematics education reform.

Narrative Identity and the Implementation of Reform

Before using a curriculum, reform or otherwise, teachers must make sense of it in the context of their existing teaching and learning practices. *Sensemaking*, a term borrowed from work in organizational studies, is an iterative process of interpretation and implementation that is situated in identity (Weick, 1995). Here, we claim that teachers' sensemaking about a mathematics reform curriculum and about their own mathematics teaching practices is situated in their identities as learners and teachers of mathematics. This extends prior research that has argued, among other things, that teachers' understandings of mathematics or beliefs about students influence the implementation of reform (e.g., Ball, 1991; Spillane, 2001). While these factors are certainly important, we suggest that identity, particularly what we call mathematics identity, is a central lens through which we can understand teachers' practices. In the paragraphs that follow, we build a case for the use of narrative identity for understanding teachers' reform practices by tracing the development of the use of narrative modes of inquiry in the social sciences and then, more specifically, in research with teachers, and, most specifically, in research investigating teachers' implementation of reform, particularly in mathematics.

One way of understanding teachers' identities as learners and teachers of mathematics is through the use of narrative. The narrative approach to understanding identity has become increasingly common in psychology (McAdams, 1993) and anthropology (Langness & Frank, 1981), as well as in education (Casey, 1993; Connelly & Clandinin, 1999). Bruner (1990) provides a conceptual basis for this focus on narrative with his assertion, based on his analysis of historical trends in social science research, that "people narrativize their experience of the world and of their own role in it" (p. 115). Clandinin and Connelly (2000) provide a similar justification in saying, "if we understand the world narratively, as we do, then it makes sense to study the world narratively" (p. 17).

In working with teachers, the use of narrative allows for a contextualized and integrated understanding of teachers' beliefs, knowledge, and prior experiences. As described by Clandinin and Connelly (1998), "we came to see teacher knowledge in terms of narrative life history, as storied life compositions. These stories, these narratives of experience, are both

personal—they reflect a person's life history—and social—they reflect the milieux, the contexts in which teachers live" (p. 150). Furthermore, research in the narrative tradition supports the claim that narratives of identity both guide the actions of individuals and frame their interpretations of new information (Drake, in press; Drake, Spillane, & Hufferd-Ackles, 2001; McAdams, 1993). In fact, Sfard and Prusak (2005) propose a definition of identities as "collections of stories about persons" (p. 16) and go on to claim that "the adherent of the narrative perspective is interested in the stories as such, accepting them for what they appear to be: words that are taken seriously and that shape one's actions" (p. 21). In the current study, teachers' mathematics narratives, and the beliefs contained within those narratives, are used to understand teachers' patterns of curriculum use and adaptation. By situating the beliefs in teachers' narrative identities, the historical and developmental origins of the beliefs remain connected to the beliefs themselves. This allows for an understanding of teachers' beliefs not as isolated statements, but as interrelated ideas rooted in teachers' identities—their stories of themselves as learners and teachers.

Recent work, particularly by Clandinin and Connelly (1998) and Craig (2001), makes the specific case that teachers' narrative identities are useful in understanding their experiences of and their roles in *reform*. Here, we are building on that prior work in two ways. First, Craig (2001) investigates and describes teachers' "lived experience of school reform" (p. 304) to answer questions about teachers' understandings and implementations of reform. In this study, we are expanding on the notion of "lived experience" by exploring teachers' narrative accounts of their learning and teaching experiences *prior* to their participation in the reform project in an attempt to understand how these earlier experiences might impact teachers' approaches to and interactions with the reform. Second, Clandinin and Connelly (1998) use narrative inquiry to understand the reform experience and claim that "[i]n truth, teachers and others can learn new knowledge and accumulate it as a personal attribute but still not change the way they 'know' their classrooms, their schools, their children, their colleagues, and their professional lives" (p. 156). Here, we are adding to this list of things that teachers "know" narratively by focusing on the *academic content* of the reform teachers were implementing—in this case, mathematics—and addressing the question of whether and how teachers' accounts of their prior experiences with this particular subject matter help us to understand their implementation of the reform.

In fact, earlier work has shown that understanding teachers' subject-specific identities as learners and teachers of mathematics helps to explain their practices in response to mathematics education reform (Drake & Sherin, 2002; Sherin & Drake, 2000) as opposed to their reform practices in other subjects, particularly literacy. Chapman (1997) identified themes, or metaphors, that framed teachers' approaches to teaching non-algorithmic problem solving and suggested that these "metaphors embod-

ied their personal experiences and personal practical beliefs" (p. 201). Other work has claimed more broadly that teachers' (and students') understandings of mathematics are constituted in and by the experiences of individuals and the memories and emotions associated with and embodied in those experiences (Friesen, Clifford, & Jardine, 1998; Simmt, 1998). Here, we are extending this work by looking closely at one aspect of teachers' mathematics reform practices—adaptation—and providing evidence that teachers' narratives of these mathematics experiences play a significant role in defining their approaches to the adaptation process when using a reform curriculum.

Curriculum Use and Adaptation

Researchers have suggested that large-scale implementation of mathematics education reform might be achieved through the widespread dissemination of reform-oriented curricula (Ball & Cohen, 1996). However, this is a complicated proposition. Evidence from both research and practice shows that teaching in reform-oriented ways requires teachers to adapt in the midst of instruction (Drake, 2002; Heaton, 2000; Lampert, 1986). Therefore, those who are trying to promote mathematics education reform through curricula face the challenge of helping teachers balance faithful curricular implementation on the one hand with necessary adaptation on the other hand. In other words, for curricula to be a vehicle for reform, teachers must be supported and guided in making adaptations that maintain the reform-oriented goals of the curriculum materials, while still meeting the needs of their students and their particular teaching contexts. The NCTM Principles and Standards (2000) describe this tension very clearly:

> One of the complexities of mathematics teaching is that it must balance purposeful, planned classroom lessons with the ongoing decision making that inevitably occurs as teachers and students encounter unanticipated discoveries or difficulties that lead them into uncharted territory. Teaching mathematics well involves creating, enriching, maintaining, and adapting instruction to move toward mathematical goals, capture and sustain interest, and engage students in building mathematical understanding. (p. 18)

In light of this complexity, we believe that it is critical to examine the ways in which teachers use reform-based curricula and, in particular, to identify patterns in the curricular adaptations that teachers make.

Prior research suggests that adaptation is a central process in teachers' use of curriculum materials and that no curriculum is used blindly or without adaptation (Ben-Peretz, 1990). Yet, little work has been done to understand this process specifically in the context of mathematics education reform. What we do know is that different teachers read curricular materials for

different reasons and in search of different kinds of information (Remillard, 2000). This certainly affects the kinds of adaptations that teachers make. Furthermore, teachers make adaptations to curricular lessons in response to a number of additional factors, including their own understandings of a lesson, the perceived abilities of their students, and constraints of time, materials, and other resources (Ball & Cohen, 1996). Recent research (Remillard & Bryans, 2004) identifies teachers' "orientations toward curriculum," defined as "a set of perspectives and dispositions about mathematics, teaching, learning, and curriculum that together influence how a teacher engages and interacts with a particular set of curriculum materials . . ." (p. 364). Here, we explore in detail both teachers' "perspectives and dispositions," as evidenced in their mathematics stories, and the influence these stories have on the teachers' interactions with the CMW materials.

In this paper, we build on our previous research in which we examined patterns in curriculum use among teachers implementing a reform-based mathematics curriculum (Drake & Sherin, 2002; Sherin & Drake, 2000). Specifically, we define each teacher's approach by what we call a *model of curriculum use* that describes how and when teachers read, evaluate, and adapt curriculum materials, as well as the meanings that each of these processes holds for teachers. We have found that the timing and content of the adaptation process within teachers' models are particularly key to understanding teachers' practices. Here, we focus on the adaptation process and connect it to teachers' narrative identities as learners and teachers of mathematics.

To be clear, adaptation is certainly not a unidirectional process. Teachers not only adapt curriculum to fit their teaching practices, but also adapt their practices in order to align with curriculum (McLaughlin, 1976). This may be particularly true in the context of reform curricula that require teachers to adapt in the midst of instruction. Although the chief focus in this paper is on the adaptations teachers make to the curriculum, it is important to keep in mind that both teachers also made adaptations in their own practices in response to their use of the curriculum. Simply trying some of the activities in the curriculum, even in adapted forms, represented significant change for these teachers.

METHODOLOGY

This study is part of a larger study investigating teachers' uses of and learning from the CMW curriculum. The materials provided to each classroom as part of the curriculum include a detailed guide for teachers with daily lesson descriptions, student activity books, end-of-unit assessments, extra practice materials, and a small number of manipulatives. It is important to note that over the course of this study, both the curriculum and the standards movement were in various stages of development and revision. As

a result, teachers were faced with a "moving target" as they tried to incorporate these ideas and materials into their practices. In fact, we feel that the constantly shifting nature of the messages to which these two teachers were responding reflects a reality faced by many teachers as they try to interpret and implement standards, policies, and curricula that are continually being altered and revised.

Data Sources

Over the course of three years, 20 teachers using CMW were studied in depth. For this particular study, two teachers were selected from the larger sample of teachers. These teachers were chosen because they were both from the same career stage, with between 7 and 10 years of teaching experience. This career stage in particular seems to be one in which teachers are especially likely to change their practices in response to reform (Drake, 2002). Furthermore, these teachers teach in the same school, are both female, and worked closely together during professional development sessions that took place as part of this research.

At the same time, the teachers differed with respect to age, grade level, number of years using the curriculum, and classroom context. At the time of this study, Beth taught second grade and was in her second year of using the curriculum. The previous year, she had used the curriculum with her first-grade students before moving to second grade with some of these students. Thus, approximately one-quarter of her students were also in their second year of using the CMW materials. Linda taught in a first-grade bilingual classroom and was in her first full year of using the curriculum, though she had consulted on materials development several years earlier at the beginning of the curriculum project.

Jackson Elementary, the school where both teachers were working, is a medium-sized urban school with approximately four classrooms per grade. The majority of the students are African American, but there is also a sizable Latino population. More than 90% of students receive free or reduced lunch. This school participates in numerous school, classroom, and curricular reform activities, though these activities are generally not linked to one another.

The two teachers, Beth and Linda, were observed teaching mathematics multiple times during the course of the school year. Most of the observations were videotaped or audiotaped and then transcribed. Field notes were taken during all observations. Table 1 lists some of the demographic characteristics as well as the number of observations for the two teachers.

Beth and Linda were interviewed either before or after most lessons about their goals for the lesson as well as about any questions that arose for the teachers before, during, or after instruction. These interviews were audiotaped and transcribed. In addition, Beth and Linda participated in

TABLE 1
Demographics and Number of Observations for the Two Teachers

Characteristic	Beth	Linda
Gender	Female	Female
Years of Teaching	8	10
Age	Early 30s	Late 40s
Grade	2	1 (Bilingual)
Number of Observations	17 (in Year 2)	13
Number of Years in Study	2	1

professional development sessions designed around the curriculum. The professional development sessions occurred for one hour, generally during the school day. They were held approximately once a month throughout the school year and were facilitated by a researcher from our project (the first author). At some of the sessions, Beth and Linda were joined by between one and three other teachers from their school who were piloting portions of the curriculum. However, Beth and Linda were the only two teachers who attended every professional development session. The sessions covered topics such as building mathematical discourse in the classroom, assessment in a reform mathematics classroom, and curriculum use and adaptation. These sessions were videotaped and transcribed.

Finally, both teachers participated in mathematics story interviews. In these interviews, based on Dan McAdams' (1993) life story interviews, teachers were asked to describe, in the form of a story, their prior experiences learning and teaching mathematics. Among other things, they were asked specifically about the high point, low point, and turning point of these experiences, as well as about particular challenges they faced and about the futures they envisioned for themselves as mathematics learners and teachers. These interviews lasted approximately one hour and were audiotaped and transcribed. We recognize that this particular method of narrative inquiry is different from and, in particular, more structured than, many other examples of narrative inquiry (Clandinin & Connelly, 2000). We developed and used this protocol both because of the conceptual grounding provided by McAdams (1993) and because of our desire, as described above, to be able to systematically differentiate among teachers' stories in order to understand differences in their implementation practices. Clearly, the choice of this particular protocol constrained teachers' responses in some significant ways, particularly in providing an external structure to the teachers' stories. However, the protocol also provided teachers with opportunities and freedom, particularly within the questions, to craft stories about particular aspects of their mathematics identities—for

example, in building narratives around a high point or a turning point in their mathematics story.

Data Analysis

Based on the observations of the teachers, the pre- and post-observation interviews, and prior work describing teachers' models of curriculum use (Sherin & Drake, 2000), preliminary models of curriculum use were developed for Beth and Linda.[3] These models were then confirmed and/or revised based on detailed analysis of the transcripts from both the lessons and the pre- and post-lesson interviews. Specifically, each transcript was coded for evidence of each of the elements of the model to ensure that the teachers' predominant models of curriculum use for the school year were identified. Transcripts in which elements of the models were not present were also coded, leading to models in which some elements are constant across lessons, while other elements are variable.

In addition, all adaptations from each lesson were identified by comparing the transcript of the enacted lesson to the written description of the lesson in the teacher's guide of the curriculum.[4] Only those adaptations that substantially altered either the content of the lesson or the role of the teacher and students in the lesson were included. Therefore, most managerial and non-mathematical adaptations, or *non-curricular adaptations*, were not included. The curricular adaptations were then coded according to types that emerged in the process of coding. In all, 13 types of adaptations were identified. The three structural, or activity-level, types of adaptations were omitting, adding, and substituting an entire activity (or large portions of an activity). Within curricular activities, there were 10 possible adaptation types: changing terminology, changing the order of activities, changing the materials used, changing the participant structures (individual to group or vice versa), increasing student control over an activity, increasing teacher control over an activity, changing the amount of time spent on an activity, and omitting, adding, or changing particular problems. Once all of the adaptation types had been identified, every observation for the two teachers was coded according to these types. Where possible given the available data, the adaptations were also coded based on the purpose and source of the adaptation. Summary accounts of each adaptation were also written.

Within the mathematics stories, specific beliefs about learning or teaching mathematics were identified. Two researchers coded each story for beliefs. Any differences between the two researchers' codings were resolved through consensus. To be clear, by teacher beliefs, we do not mean isolated phrases or comments, but rather ideas and understandings about learning and teaching mathematics that were embedded in the teachers' stories of themselves as learners and teachers of mathematics. This embedded quality provides both a historical and a developmental context for understanding

the nature and meaning of the teachers' beliefs. Earlier research has identified different types of mathematics stories told by teachers with different identities as learners and teachers of mathematics (Drake, in press; Drake, Spillane, & Hufferd-Ackles, 2001). These story types differ in terms of their overall narrative structures—in the tone, specificity, and plot of the stories as a whole. In this paper, we are building on that work by considering specific beliefs within the teachers' stories. Finally, for each of the teachers, their models of curriculum use were examined in light of the themes identified in their mathematics stories. Areas in which the mathematics story themes helped explain the observed models were identified. In all, three such areas were identified—early experiences with mathematics, current perceptions of self as a mathematics learner, and family influences.

BETH AND LINDA AS MATHEMATICS LEARNERS AND TEACHERS

In this paper, we claim that we can understand more about the role of adaptation in Beth and Linda's models of curriculum use by first considering their identities as learners and teachers of mathematics, as revealed in their mathematics stories. These identities incorporate not only the teachers' beliefs and knowledge about mathematics and teaching mathematics, but also the historical roots and contexts of the teachers' beliefs and knowledge. The two cases in this study present two different patterns of adaptation. We can use the teachers' mathematics stories to help make sense of the ways in which the teachers adapted the curriculum. Although these stories are different from one another in many ways, it is interesting to note that they are both "turning point" stories (Drake, in press), in which early negative and failing experiences with mathematics are both redeemed (McAdams, 1993) and reinterpreted through the lens of recent successful encounters with mathematics.

Beth's Mathematics Story

Beth's early experiences with mathematics were mostly negative. She clearly recalled specific instances of failing in mathematics and feeling "stupid" in mathematics. In addition, she felt that her childhood mathematics instruction was often "over her head." In describing her early experiences with mathematics, she said the following:

> The low points would just be every day of not understanding because there were no manipulatives. You were supposed to imagine everything—visualize it in your head—and I wasn't good at that. I remember hating story problems. . . . I couldn't understand why. Now I love them. Now I can look back and understand why. I

wasn't a strong reader. I wasn't a fast reader and I wasn't a strong reader and, again, when you read words without a picture, I didn't have my visual and so it was hard for me to understand what was happening.

However, Beth had recently experienced a turning point in her relationship to mathematics in which she realized that these early failures occurred not because she was stupid, but because she was a very visual learner and mathematics had not often been presented to her visually. In other words, Beth now interprets her early failures with mathematics as the result of a mismatch between her own style of learning (very visual, weak in reading) and the way in which her teachers taught mathematics with no visuals, no manipulatives, and no explicit connections among reading, visualizing, and solving word problems.

Over the course of her participation in this curriculum project, Beth began to believe that mathematics was not as "black and white" as she had previously thought. Instead, she felt that understanding mathematics meant understanding that there could be multiple correct ways to solve a single problem and that mathematics was more of a system or a language than a set of cut-and-dried procedures. As she said in one professional development session:

I think that everybody is on the same page at their own level. And it could be that one person has to do it this way and another person can do it more intellectually, but they are all doing, maybe, the same problem. . . . I feel in my classroom they are on the same page, however, this guy is definitely not doing it the same way this guy is and they are learning from each other.

Finally, Beth clearly viewed herself as continuing to learn about mathematics as a discipline, both through and in addition to learning about mathematics teaching.

While Beth had become comfortable with implementing many of the goals of reform in her teaching, she still saw her practice as quite mixed. Beth pointed to a number of factors to explain this back-and-forth movement between "old" and "new" ways of teaching. Most prominent among these explanations was her level of stress and her focus on personal versus professional issues—when life at home or at school became difficult or complicated, Beth shifted back to her more traditional ways of teaching. In her mathematics story, Beth included this tendency to shift back to traditional teaching as one of the primary weaknesses in her mathematics teaching:

Weaknesses? That when I'm overstressed I go back to the way I always did, that's it. I lose sight of where I'm going and I just deal with the here and now.

Several times over the course of the two years, events in Beth's family—she has two elementary school-aged children—or at school prevented her from

spending the kind of time she felt was necessary for her to teach in a reform-oriented way. At the same time, she often made use of her children and her experiences with her children as guides for how her students might respond to particular concepts or teaching methods.

Linda's Mathematics Story

Linda had no clear memories of learning mathematics in elementary school. When asked about an early memory of mathematics from her grade school years, she had trouble recalling anything. After thinking for a while and recalling some high school experiences, she concluded:

> I guess I never thought of myself as a math person, student either, math anything. So, it's probably blocked out. I don't remember myself doing anything. I remember things like being a cashier at a part-time job and having trouble changing money. I still have some trouble with that! But I don't remember anything prior to geometry in eighth or ninth grade.

Linda's first specific memory of mathematics was of struggling with high school geometry:

> I do remember algebra, no, not algebra, geometry. . . . It's the same kind of conceptual thing that I don't get. . . . Somehow I passed geometry. I don't know how.

Linda's descriptions of her current beliefs about mathematics teaching and learning, as well as about herself as a mathematics learner, focused on a turning point experience she had when she was a teaching assistant. Through this experience, she learned that students learn best by doing:

> Really, watching those kids play that game is what finally made me realize—a lightbulb went on. Honest to God, it was a lightbulb, in every respect. It was a major shift in the sense of watching the kids learning from doing and playing, but also understanding what was going on. I really can pinpoint that—it was major.

At the same time, Linda had had a series of recent experiences that convinced her that she could be a capable mathematics learner, given the right context. Describing her experiences with a professional development program, she said:

> We went four months, five months. I really liked it. I liked their philosophy. It felt meaningful to me. So that was a good experience, the actual learning part of it.

Linda later went on to describe a similarly positive experience she had taking algebra in preparation for graduate school:

They offered a night school class. . . . That lady there, I loved algebra because of her. She made it so nice . . . she made it just fun. All of us were returning students, which I think helped too. None of us were young whippersnappers for whom algebra was so easy. She really made me feel like I could do it, and that algebra had some meaning, could have some meaning to me.

Unlike Beth's children, Linda's two daughters were in their 20s during the time of the study. In fact, Linda did not begin teaching in classrooms until her children were teenagers. As a result, she brought years of experience teaching her own children to the classroom. The primary lesson Linda seemed to have learned from the experience of watching her daughters learn was that learning requires time, patience, and repeated exposure. Linda described how watching her own children learn before she began teaching in the classroom influenced what she believed about teaching and learning:

I didn't start teaching until later in life and I had gone through raising, I had raised my kids. They were grown or growing. . . . That was useful, to see how my own kids thought and learned . . . things take a lot more time than I would have thought had I not had my own children. Things take more time and they will get it, but with time and patience and a lot of extra stuff. And I think sometimes teachers and, this is what I think, you feel like they're not going to get it so you have to give it to them. They will get it.

MODELS OF CURRICULUM USE AND THE ROLE OF ADAPTATION

In earlier work (Sherin & Drake, 2000), we found that three processes—read, evaluate, and adapt—describe teachers' uses of a reform mathematics curriculum. By *read*, we mean the process of looking at any curricular materials, including the teachers' guide and student workbook pages. *Evaluate* involves judging the curricular materials according to criteria determined by the teacher. This could include teachers' making decisions about the appropriateness of the lesson for the students or for the teacher, the order of the activities, the materials to be used, or the expected student responses. *Adapt* means making significant curricular changes in a lesson. Again, these changes primarily involve either the presentation of the conceptual material or the role of the teacher and/or students in the lesson.

Teachers' models of curriculum use describe teachers' chronological use of these three processes (read, evaluate, and adapt) in the course of preparing for, teaching, and evaluating a curricular lesson. In particular, the models provide a visual representation of the order in which teachers engage in these processes and whether these processes are completed before, during, and/or after their teaching of the lesson. These models serve as a means for understanding teachers' day-to-day practices using a

TABLE 2
Location and Types of Adaptations for the Two Teachers

Teacher	Location of "adapt" in model	Common types of adaptations
Beth	Before, during, and after instruction	Omitted activity Terminology Increased teacher control Increased student control Added activity (review)
Linda	Before and during instruction	Substituted activity Extended time allotment Changed participant structure (individual to group)

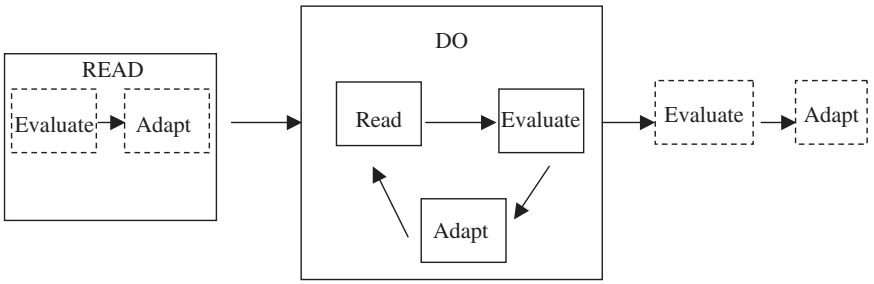

FIGURE 1. Beth's Model of Curriculum Use.
(Dotted lines indicate elements present in model only for some lessons)

reform-oriented curriculum. One particularly important aspect of the models is the process of adaptation. Both the location of adaptation within the teachers' models and the types of adaptations each teacher makes provide interesting insights into teachers' patterns of curriculum use. Therefore, in the remainder of this section, we present each teacher's model of curriculum use, but with a focus on the role of adaptation within each of the models. Before presenting the results for Beth and Linda, we have included a table (Table 2) summarizing these results to allow for a quick comparison both within and between the teachers.

Beth's Model of Curriculum Use

Beth's model of curriculum use (Figure 1) indicates that she generally read the curriculum before teaching it. Many times, she also evaluated and, when necessary, adapted the lessons before teaching. She also read, evalu-

ated, and adapted lessons while she was teaching them. After the lessons were finished, she sometimes engaged in another iteration of evaluation and adaptation, but this was done primarily with regards to teaching the lesson again in the following year and only secondarily to inform the next day's instruction.

In Beth's model of curriculum use, adaptation was important but not central. In other words, adaptation was a regular and purposeful aspect of Beth's use of the curriculum, but it was not something she necessarily did before, during, and after every lesson. Across the 17 observed lessons, Beth adapted *before* 9 of the lessons, adapted *during* 16 lessons, and adapted *after* 5 lessons. The fact that the adaptation process both before and after lessons was only sometimes part of her model indicates both her trust in the curriculum and her belief in her own abilities to adapt to students while teaching. In a post-observation interview, Beth discussed her decreasing reliance on her own adaptations and her increasing trust in the curriculum:

> I highlight vocabulary, procedures, I trust the book now. I know it has a natural flow between what's here and what's here. I trust it more. . . . I understand the connections more. . . . There is a reason they are using these two numbers—in that sense I am still following the book.

Beth's increasing trust in the curriculum was neither a blind allegiance nor an attempt to relinquish the responsibility for her own mathematics teaching and have the curriculum do her work for her. Instead, Beth's trust in the curriculum was the result of more than a year of experience with the curriculum and an understanding of the big ideas that frame the curriculum. Rather than relinquishing responsibility, she instead seemed to be shifting the locus of her responsibility from redesigning curricular activities to preparing herself to understand and build on student responses during instruction to achieve curricular goals.

In the 17 lessons observed during Beth's second year of teaching CMW, 110 adaptations were noticed. The largest single group of adaptations was *omitted activities* which accounted for 22.7% (N = 25) of her adaptations. This is not surprising because the curriculum included more activities for each day than could be accomplished in a one-hour mathematics class, so some omissions were required. Beth's omissions were usually carefully chosen to ensure that the main conceptual points of the lesson were covered. For example, she would choose to spend time on students' questions and explanations instead of on procedural practice. At the same time, 10 of the adaptations, or 9.1%, involved *adding an activity* to a lesson, specifically adding a review of the previous lesson. Again, these adaptations generally served to reinforce the conceptual goals of the lesson.

After omitted activities, Beth's next largest group of adaptations (16, or 14.5%) had to do with *terminology*, both the invention of new terms and,

more often, the elaboration of terms presented in the curriculum. These adaptations often involved Beth or the students making connections, sometimes conceptually misleading, to activities or discussions they had had in other subject areas. For instance, when reviewing two-digit addition with her class, Beth made a link between the term "digit" in two-digit and their discussion of dinosaurs' "digits" (i.e., fingers and toes) in science. This reference to dinosaurs did not help students connect "digits" with numbers and, as a result, did not assist them in understanding the meaning of the term "two-digit." On the other hand, when introducing bar graphs, Beth elicited her students' knowledge of other meanings of the word "bar," such as bars on a jungle gym. In this case, her students' conceptions of bar graphs did seem to be enhanced by this discussion, as the regular spacing between the bars on the playground reinforced a conceptually important point about bar graphs as a representation of data.

Finally, the analysis of Beth's lessons revealed two conflicting patterns in her adaptations of curricular lessons. While 9.1% of the adaptations (N = 10) involved giving students more control over the content and direction of the lesson, 10.9% of her adaptations (N = 12) made the lesson more teacher directed than called for in the curriculum. In practice, this meant that in some lessons Beth allowed students to come up with strategies or ideas that the curriculum suggested she directly tell them. In other cases, Beth told students "correct" answers rather than letting them explore as the curriculum suggested.

Example of Beth's Model of Curriculum Use

A representative example of Beth's model of curriculum use occurred in March of her second year using the curriculum. This lesson occurred midway through a unit on multi-digit subtraction. The lesson consisted of three main activities. The first activity was a "checkup" in which students solved two multi-digit subtraction problems. In the second activity, a "number path" was introduced as a representation for students to use in solving two-digit subtraction problems. The number path looked like a brick path around the edge of the students' papers with numbers from 1 to 100 written in order on the bricks. The idea was for students to use a toothpick to mark the starting point in a subtraction problem and then to use the number path to help them solve the given problem. The teacher's guide presented an example of how to set up a specific problem (65 – 28) on a portion of the number path (Figure 2). Note that as illustrated by the teacher's guide, the toothpick is on the line between 65 and 66. In the third activity of the lesson, the teacher and students were supposed to discuss their favorite methods for solving multi-digit subtraction problems.

When the researcher arrived to observe Beth's class on this day, Beth had not yet prepared for the lesson. Thus, she reviewed the curriculum

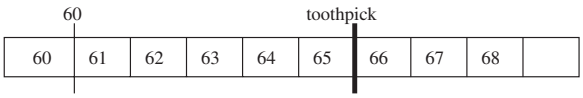

FIGURE 2. Using the number path to solve 65 – 28.

guide in front of the researcher and talked about what she was thinking and doing during this process. To start, Beth read the lesson as described in the teacher's guide. Beth initially considered skipping the number path activity because her students were already doing well with two-digit subtraction. However, she decided to go ahead with the activity because she was "curious" about what her students would do. In making this decision, she also made the decision to let her students control the content and direction of this portion of the lesson, rather than directing them to a particular use of or meaning for the number path.

Beth then thought about what strategies her students might use with the number path. No possible student strategies were presented in the teacher's guide. For the problem suggested in the teacher's guide (65 – 28), Beth expected her students to take away or count backward 5, then 10, then 10 again, and then 3 for a total of 28 from the 65. She tried this strategy herself, using the complete number path in one of the student's books, and was satisfied with the results. Beth then compared the materials required for the lesson to the materials that she had available. In particular, the curriculum called for the students to use toothpicks to mark numbers on the number path and Beth could not find any toothpicks. She decided to have the students draw lightly with pencils instead. Finally, Beth decided not to use the checkup suggested in the curriculum and chose instead to begin the lesson with an oral word problem in preparation for upcoming standardized tests. In summary, Beth made *evaluations* and *adaptations* around several issues, including student control of the lesson, anticipated student responses, and materials, *before* instruction.

When introducing the number path activity to her class *during* instruction, Beth said:

> We are going to be looking at a number pathway; it is kind of this funny-looking thing. We are going to look at this and I am going to put a problem on the board and I want you to figure out, using your own mind and what you already know, and then you make an idea or a plan of how you would solve this problem. So, I am going to put a problem up here and we are going to try and brainstorm some ways to solve this problem using what you have in front of you.

This statement reflects not only her earlier decision to let students control the content and direction of the lesson, but also a move *during* instruction to explicitly tell students that they would have this kind of control. After orienting the students to the number path by having students point out

some of the interesting features of the path (some student responses were, "Groups of 10," "The pathway has numbers"), Beth then restated her directions to the class:

> Do you think this number path could help you? Take a few minutes to look at it and think about how you could use this number path to figure out the answer.

Students then spent a few minutes, working either alone or in pairs (the choice was left to the students), on finding a solution to the problem using the number path. Up until this point, the class had proceeded as Beth had planned.

Several minutes later, a problem arose in which there were discrepancies among some of the students' answers. When doing the problem 65 – 28, most of Beth's students said they counted backward 28 squares from the 65. However, some of these students arrived at 37 as an answer, while others came up with 38. The difficulty was that neither Beth nor her students could figure out whether to count the 65 as the first of the 28 squares to be taken away or whether they should start counting at the 64 square. Beth made several *adaptations* in response to this unanticipated difficulty, including leading students in another solution method with the number path (using groups of 10), having two students solve the problem using numerical methods with which they were already familiar, and trying a simpler subtraction problem using the number path (these last two adaptations were not included in the curriculum). On the videotape, she was also observed *reading* the description of the lesson in the teacher's guide again. She said to her class:

> So the answer [using the second number path method] is 37. I really need to figure out this answer by Mr. Green's method[5] because we are getting them really close but we are not nailing the same answer every time. . . . Who would go over there and check it for me on the board while the rest of us do another one on the number pathway? Let's try a different one. This time, let's do something a little simpler, 23 take away 14.

Ultimately, Beth realized using the simpler problem (23 – 14) that the method she and most of the students were using (starting on the 23) was not correct:

> We do have to start with that next number down [22]; I am not getting it either. I just told you that you need to start with that number [23], but it is the next number down. Mariana and I were sitting here and she said, "Mrs. R., it's 10," and I'm sitting here and I know the answer and it is not 10.

Beth was still confused until she came up (after asking the two researchers observing the lesson for some help) with the *term* "hopping" to describe

the movement from one square to the next and realized that they should count the number of hops and not the number of squares. As she explained to the class:

Beth: So it is kind of like hopping back, but our first hop would land here [on the 22]. If we did that, it might even help us, so put your number on 23 and let's actually hop back. Start at 23. Now let's hop and count how many. [The class counts 14 hops together.] That should be the number that you landed on. When you got to 14, what number were you on?
Students: Nine.
Beth: Let's try it again. [The class does the same problem again together.] How many of you when you said 1 pointed at 23? That is our mistake; when we say 1 we are hopping and then we'll be at what number?
Students: Twenty-two.

The rest of the lesson proceeded as planned. *After* the lesson, Beth made some evaluations of what had happened and considered how she might teach this lesson in the future, but she did not make any specific adaptations in the plans for the next lesson because she was satisfied with her students' overall progress in understanding two-digit subtraction. She did comment that having a better *visual* to use on the chalkboard might have helped her, especially when the class started to struggle.

As this example shows, Beth was generally willing to try the activities presented in the curriculum. At the same time, she adapted these activities while trying to maintain the goals of the lesson given the materials and time that she had available. Furthermore, she was comfortable in the role of teacher-as-learner, adapting the lesson as she responded to her students' ideas and to the mathematical issues that arose during instruction.

Linda's Model of Curriculum Use

Linda's model of curriculum use (Figure 3) was very different from Beth's model. Specifically, Linda's model was distinguished by the use of four different sources of information in the process of reading a lesson and by repeated iterations of single lessons. Each lesson was taught at least four times, as Linda used each of the four sources of information one or more times for each lesson or topic.

In Linda's model, adaptation was central to her lesson planning and curriculum use. No core (as determined by Linda) mathematical topic was taught without several iterations of adaptation and teaching using several sources of information.

Only 19 adaptations were found in the 13 lesson transcripts from Linda's class. However, in this case, simply counting the number of adaptations is quite misleading because on 7 of the 13 days in which Linda's class was observed, the lesson was a complete adaptation of the curricular lesson.

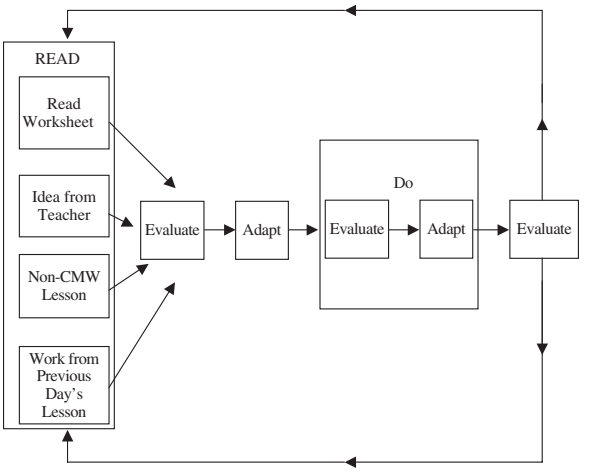

FIGURE 3. Linda's Model of Curriculum Use.

Therefore, on each of these seven days, only one adaptation was noted, but it was an adaptation that encompassed the entire lesson. In fact, Linda's teaching differed considerably more from that described by the curriculum than Beth's instruction did. While Beth used the curriculum as the general framework for her lessons on most of the days that she was observed, Linda followed the curriculum only on half of the days that she was observed.

Nine of Linda's adaptations, or 47.4%, involved using a different activity than the one suggested in the curriculum to teach a particular concept. Another four, or 21.1%, extended the time allowed for a particular activity or lesson. Often these extensions were dramatic—for example, increasing the time spent on "introducing" teen numbers from half a day to one week. Finally, another 21.1% (N = 4) of her adaptations changed an activity from something students did on their own to something they did in groups or as a whole group, closely facilitated by Linda. According to her pre- and post-observation interviews, Linda's adaptations generally were intended to allow students to build very deep conceptual understanding of a particular topic. In other words, Linda would change, extend, and lead activities with her students until she felt they had mastered the intended concept.

Example of Linda's Model of Curriculum Use

The first-grade CMW curriculum begins with a unit on "break-aparts," or the concept of numbers embedded in other numbers (e.g., 2 and 4 are break-apart partners of 6). Because of the importance of this topic in students' developing understanding of number (Fuson, Smith, & Lo Cicero, 1997), this unit is designed to last two or three weeks and to provide

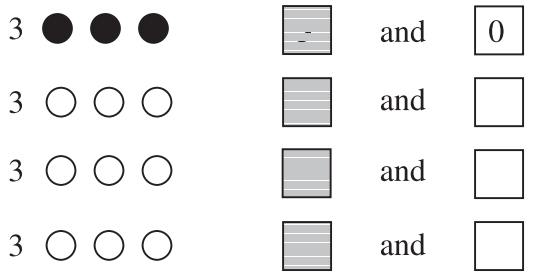

FIGURE 4. Portion of student page for break-aparts of 3.

students with a firm basis for continuing to explore number sentences throughout the year. Thus, this unit is explicitly designed as an in-depth exploration of numbers embedded in other numbers. Despite this, Linda's class worked on break-aparts much longer, for a total of more than six weeks. The following example comes from September during the class's first week on the unit.

In this lesson, Linda's students were working on finding the break-aparts of 3. This was a lesson they had begun during the previous class; students had already completed part of the main activity for the lesson. However, Linda explained to the researcher that the activity had not gone as well as she had hoped and that she felt it was too soon for the class to move into break-aparts. She also told the researcher that they would go ahead and try the next activity of the lesson, but made it clear that she was not sure if it would work.

For this activity, the class worked from a page in the student workbooks in which four sets of three circles were presented. As shown in Figure 4, in the first set of three circles, all three circles were shaded. This was intended as an example to illustrate that 3 and 0 are break-apart partners for the number 3. The idea was for the class to use the other sets of circles to identify the rest of the break-apart partners for 3 (2 and 1, 1 and 2, and 0 and 3).

However, during instruction, Linda made a series of adaptations of the activity. First, she made a conceptual adaptation, changing the intended purpose of the activity. Rather than focus on finding all of the break-aparts for the number 3, Linda focused the students' attention on a specific break-apart, 2 and 1, and asked the class if it mattered which of the two circles were shaded and which one was left unshaded. In doing so, she did not include two key parts of the activity which were (a) to find all of the break-apart partners for 3 and (b) to see the break-apart partners as numbers.

As Linda carried out this revised activity with the class, she also made a number of other adaptations. These adaptations focused on using different kinds of materials to help students work through the problem she had

posed. Those materials included counters, colored paper, and colored chalk. Furthermore, it is clear from the field notes that Linda planned and adapted in the midst of instruction. For example, Linda wanted a manipulative to help students see and compare different combinations of two shaded circles with one unshaded circle. She said out loud to herself:

> You know, I like to use those multicolor things [counters], but I don't have enough—oh wait, but we're only doing 3, so that's okay. (Field notes)

When the colored counters did not appear to Linda to be working, Linda then found colored squares of paper to tape to the board. She continued to question the students about the meaning of the order of the different colors, but the students continued to be confused by her questions. Thus, in a final adaptation, Linda used colored chalk to represent the page from the students' books on the board for the class.

Interestingly, after several adaptations, Linda began to realize that she had misunderstood the students' activity page, saying, "This isn't exactly what you're supposed to be doing." At the end of class, Linda discussed this confusion with the researcher:

> I don't know what they [the curriculum] wanted them [the students] to do—I didn't understand. The example on the page was three shaded, which is easy.

After the researcher explained the intended purpose of the activity to Linda, Linda decided to reteach the activity again the following day. As a result, the class would continue with a worksheet they had now been working on for two days. In a conversation with the researcher after class, Linda explained that she thought the intended purpose of the activity (seeing break-aparts of 3) was useful and that "if students got anything out of today" they might even be in a better position to learn about break-aparts the following day in class:

> Oh, I understand. They [the curriculum] should have done striped and shaded or something. Oh well, this will still work. We can do it tomorrow with the turtles [the next problem on the students' activity page]. It might be better for my kids anyway, if they got anything out of today which I'm not sure they did. (Field notes)

One week later, during the next observation by researchers, Linda continued to teach the same lesson, but this time with noncurricular materials that she had used in previous years. At the beginning of the class period, she indicated to the class that they might continue to work on this lesson for yet another day, saying, "I don't know if we'll have time, but if not, we'll do some today and some tomorrow." As it turned out, at the end of the lesson, the teacher felt that the students had still not fully "grasped" the concept of

break-aparts, so she said she would continue this lesson the next day. At this point, after working for more than one week, the class was only two lessons into the unit.

One month later, Beth and Linda participated in a professional development session in which the topic of break-aparts (though with numbers greater than 3) arose. Beth explained how she had students recite the break-apart partners out loud and in order so that they could recognize patterns and remember the partners more easily. Linda thought this was a good idea and said that she would try it with her class:

> I think I am definitely, I like the verbal thing, the out-loud thing, and I think I am going to add to it by saying, having them . . . read all the list, the whole list. I think that would actually demonstrate the pattern to them.

Thus, more than six weeks after beginning to teach break-aparts, Linda was still struggling to reinforce and reteach the concept with the apparent goal of having all of her students achieve deep conceptual understanding. Over the course of the six weeks, she used curricular materials, noncurricular materials, and teacher suggestions to *adapt* before instruction. She also frequently *adapted* during instruction in response to the understandings and misunderstandings both she and her students were constructing. Although this example is from the beginning of the school year, this pattern of repeating a lesson many times continued throughout the school year.

Beth and Linda—A Summary

Clearly, there were numerous differences in the models of curriculum use of these two teachers. Beth adapted before, during, and after instruction, but generally taught each lesson only once before moving on. In addition, her adaptations usually maintained the conceptual goals of the lessons and often revolved around issues of terminology and student control over lessons. On the other hand, Linda's model of curriculum use was defined by her multiple iterations of single lessons. Many of these adaptations addressed the conceptual goals of the lesson, but often using materials and activities other than those provided by CMW. Based on the single examples presented above, it may seem that the teachers' curricular changes or adaptations were somewhat ad hoc or accidental. However, the pattern of similar changes observed for each teacher across the school year makes us believe that these were more purposeful moves on the part of the teachers.

UNDERSTANDING ADAPTATION THROUGH THE LENS OF TEACHER NARRATIVE

The teachers' mathematics stories covered a wide range of topics, including past, present, and future experiences with mathematics, as well as

experiences with mathematics both in and out of school. However, upon detailed analysis and coding of the mathematics stories and the teachers' mathematics practices, it became clear that for these two teachers, their classroom practices were most closely related to three particular aspects of their mathematics stories. First, the teachers' early experiences with mathematics, or more specifically their interpretations of these early experiences, were closely connected to the ways in which teachers thought about their students and, therefore, to the kinds of adaptations they made for their students. In other words, teachers tended to view their own instruction through the lens of their early experiences as students. Research tells us that teachers' beliefs about their students are very important in the implementation of reform (e.g., Spillane, 2001). Now, we are adding to this research by situating these teacher beliefs in teachers' identities as learners of mathematics. Second, teachers' conceptions and interpretations of their more recent experiences as adult learners of mathematics affected the level of efficacy teachers felt when it came to their ability to adapt the curriculum. In particular, Beth's and especially Linda's recent successes with mathematics empowered them in relation to the curriculum and freed them to make the kinds of adaptations they felt were appropriate. Third, specific episodes in the teachers' mathematics stories, especially those concerning interactions with family, were particularly important for understanding the specific types of adaptations teachers made. In other words, the teachers' *professional* identities were strongly influenced by their *personal* contexts. In the remainder of this section, these findings are discussed using examples from the mathematics stories of Beth and Linda.

The Teachers' Early Experiences and Patterns of Adaptation

The teachers' interpretations of their early experiences with mathematics were reflected in their patterns of adaptation in two different ways. First, Beth's early experiences provided a mirror against which she viewed her own instruction. In this case, Beth's memories of her early experiences served as a vision of what mathematics instruction should not be.

These interpretations are reflected in Beth's pattern of making adaptations that focused on terminology in order to help students make the kinds of explicit links between mathematical language and mathematical concepts that she felt were missing in her earlier experiences with mathematics. Beth's understandings of her early experiences also help to explain her adaptations adding review activities to lessons. Again, these review activities helped her make the kinds of connections for students that she would have liked when she was a mathematics student. At the same time, her adaptations to increase student control over activities can be understood in light of her memories of not understanding what was happening in mathematics

classes. By giving students control over activities, she empowered them to create their own understandings of the mathematical content. Finally, many of Beth's evaluations of lessons, as in the example presented in the previous section, focused on the effectiveness (or lack thereof) of the visuals used in the lessons. This lens for evaluation is clearly related to her interpretations of her earlier failures as being due to a lack of visuals in her mathematics instruction.

On the other hand, Linda does not think of herself as a "math person" or student and cannot clearly recall her own experiences learning mathematics when she was her students' age. As a result, she, unlike Beth, did not have a vision or memory of elementary mathematics that she could either emulate or counteract, as in the case of Beth. She needed to create a new vision of elementary mathematics teaching without a template to start from. This lack of a starting point, or vision, was reflected in Linda's multiple attempts to teach a single lesson and in her pattern of continuous adaptation before, during, and after instruction.

Although Linda did not have any clear memories of learning mathematics in elementary school, she did recall her experiences in high school geometry. In addition, she had a very specific interpretation of these experiences and their relationship to her current practices:

> [In geometry], why can't you just go, I know that you go, when you have A and whatever, I know that it gets to C, but I just couldn't write it all down. I couldn't make myself write every individual step. It just didn't make sense. It's typical of me that I get the big picture. That's what happened with me . . . with this project. It really dawned on me that I don't read directions and I can't follow directions. That's exactly what geometry was. You have to follow step-by-step directions and write them down. I could not do that for the life of me. I just couldn't make myself know that A goes to B and B goes to C. I knew that A got to C and why doesn't everybody?

It is striking how similar Linda's description of her experiences with geometry are to her experiences with the curriculum—she sees the big idea and she understands the end goal, but she has difficulty with the steps in between. In the case of the curriculum, she knew the big conceptual goal she wanted her students to achieve, but it took her many iterations to figure out how to get there as she tried and adapted many different intervening steps. In the case of geometry, she understood the endpoint, but she wanted to leave out the intervening steps. In the quotation above, it is also interesting to note that Linda recognizes this similarity. She explicitly links her interpretation of her experiences with geometry to her difficulty following directions when using the curriculum. In fact, as Linda's model of curriculum use suggests, she often did not read the directions for lessons, instead relying on other sources of information. When she did read the directions, she frequently made major adaptations to them.

Teachers' Current Understandings and Patterns of Adaptation

In addition to their interpretations of their early experiences, Beth and Linda's *current* perceptions of their own strengths and weaknesses as mathematics learners and teachers were reflected in their patterns of adaptation, particularly in their willingness to adapt different aspects of the curriculum. Further, the teachers' more general understandings about what it meant to learn and teach mathematics could also be linked to their patterns of adaptation.

Beth's model of curriculum use reflected her new understandings about mathematics and about her identity as a mathematics learner and teacher. Her tendency to adapt throughout the implementation process—before, during, and after instruction—is understandable in light of her recently developed confidence in her own abilities as both a learner and a teacher of mathematics. Perhaps more important, her pattern of continuing to read, evaluate, and adapt even in the midst of instruction is really a hallmark of reform-oriented mathematics teaching and indicates both a willingness and an ability to listen and respond to student understandings while teaching. Finally, the large number of adaptations in Beth's lessons focusing on language and terminology is not surprising in light of Beth's new understanding of mathematics as a language.

However, this shift toward reform-oriented teaching and reform-oriented curriculum use was not straightforward or problem-free. This is illustrated by the fact that the number of adaptations she made to increase teacher control over a lesson (N = 12) is nearly the same as the number of adaptations made to increase student control over a lesson (N = 10). In fact, the tension Beth felt between her new beliefs and understandings about mathematics as a process of finding multiple solutions and her old tendencies to teach in a very controlled, teacher-directed manner was a consistent theme in both her mathematics story and in her post-observation interviews. She described this tension in the following way in her mathematics story interview:

> In the future, I would like to be this mellow math teacher that goes with the flow and teaches them as we go, you know, learn things together. It started happening at the beginning of the year, but then, I think when you come to something new you always revert to the old way. So, that's what I'm doing all this year. The book is telling me to do it a new way, but yet it's new ways of teaching, so I throw in the old. Like today was a new that I threw in the circle and talking about math. Then I went back to the old and then . . . it's like a roller-coaster ride.

Linda's recent turning points, as described in her mathematics story, are clearly reflected in Linda's model of curriculum use in which she was constantly striving to create the right context for students to build deep understandings of mathematics. Based on her belief that students learn through doing, she provided numerous opportunities for her students to

"do" math, rather than providing them with answers. In addition, her growing confidence in her own mathematics abilities allowed her to feel that she was capable of adapting and creating mathematical lessons, as reflected in her model of curriculum use which was defined by multiple whole-lesson adaptations.

Family Matters and Patterns of Adaptation

Finally, what the teachers learned from family members played a significant role in the kinds of adaptations they made. In the cases of Beth and Linda, the influential family members were their own children.

Beth's two children were close in age to her students during the years of the study. Thus, when planning and reflecting on her instruction, she often kept her own children in mind as a way of evaluating her teaching. Her interactions with her children motivated her to work harder to be able to teach in a more interactive, reform-oriented way. As she explained it, she felt that this way of teaching was much closer to the way she taught her own children:

> It's a more interactive math curriculum. What I see CMW do is how I would teach my own children, it's the way you develop the little steps and learn and interact. It's the freedom to say, "What does this mean?" and, "I think we should do it this way," and someone else saying, "I don't understand," which is what you do with your children.

Ultimately, Beth believed, based on her experiences as a learner, teacher, and mother, in many of the reform principles embodied in CMW. This reform orientation is reflected in her model of curriculum use, which incorporates adaptation throughout the process, as well as in many of the specific kinds of adaptations she made. However, Beth's comfort with traditional ways of teaching, combined with the many demands placed on her in both her personal and professional life, are also reflected in her patterns of adaptation. Beth described her struggle to try to interact with her students in the same way she did with her own children:

> I thought that deciding what to pursue in depth from among the ideas that students bring up during a decision or discussion is a difficult one. I mean a lot of these I think are so difficult, they are so what I have to sit and think about that you're supposed to just naturally flow into and with my own children I don't sit and think about, but with a classroom I have to sit and think about because it goes against my paradigm of what a teacher does, what I have been raised on.

In a sense, Beth is trying to capture or create an "intergenerational" (Friesen et al., 1998) community of mathematics in her classroom—a

community that has arisen organically in her own home, but runs counter to her traditional definitions of classroom teachers and teaching.

Like Beth, Linda's role as a teacher and observer of her own daughters' learning of mathematics significantly informed her mathematics teaching and her use of the curriculum. Recall that in her mathematics story, Linda said:

> That was useful, to see how my own kids thought and learned . . . things take a lot more time than I would have thought had I not had my own children. Things take more time and they will get it, but with time and patience and a lot of extra stuff . . . you feel like they're not going to get it so you have to give it to them. They will get it.

Two beliefs in this statement are key to understanding Linda's model of curriculum use and patterns of adaptation. First, there is the idea that "things take a lot more time." Linda spent considerably more time on each topic than the curriculum suggested, but this is understandable given her belief that time is the critical factor in building students' understanding. Second, Linda comments that "you feel like they're not going to get it, so you have to give it to them." Again, this belief is reflected in Linda's willingness to present a single topic to students multiple times in multiple ways, rather than just telling them what she wants them to understand. In combination, these statements point to Linda's fundamental belief that given enough time and the right context, children can figure things out for themselves, a belief that is reflected quite clearly in Linda's model of curriculum use.

IMPLICATIONS

In this research, we have looked closely at the ways in which teachers used a reform-based curriculum and, in particular, at the adaptations that teachers made before, during, and after instruction. We found not only that the teachers had models of curriculum use that helped to explain their approach toward adapting the curriculum, but also that the teachers' narrative identities as learners and teachers of mathematics helped to frame our understanding of these approaches. By connecting research on mathematics education reform with research on narrative identity, we believe that we have enhanced our understanding of the relationship between teachers' narratives and their mathematics teaching practices.

To be clear, these two cases of teachers' practices in the context of reform are not intended as good and bad models of curriculum use or strong and weak patterns of adaptation. Working with a complex, conceptually rich curriculum, different teachers make different choices and adaptations. In the cases of Beth and Linda, both were quite reform-oriented in that both

were trying to help their students achieve strong conceptual understandings. However, drawing on their past experiences, their current identities, and their desire to re-create the kinds of intergenerational mathematics learning found in their homes, they each had very different ideas about how to achieve that goal. While some readers might be tempted to applaud or criticize particular teaching moves or decisions, the important point is that both teachers were thoughtfully and reflectively working to change and improve their mathematics teaching practices through their piloting of a reform curriculum. Furthermore, the consistency of their models of curriculum use across the school year suggests that these teachers were not interacting in a haphazard or ad hoc manner with the curriculum, but instead were engaging in deliberate ways with the curriculum materials.

Before concluding, we would like to discuss three issues that have been raised in the current study and that we believe need further consideration. First, what does it mean for teachers to "follow" a curriculum? As stated earlier, we agree with other researchers (Ball & Cohen, 1996; Ben-Peretz, 1990; Remillard, 1999) that no curriculum is "teacher-proof." Yet prior research has not carefully considered patterns of curriculum use for individual teachers. One of the contributions of our research is the discussion of models of curriculum use as a new lens for interpreting teachers' practices. Particularly in the context of mathematics education reform where teachers are often introduced to reform through the adoption of new curriculum materials, we believe that such models can be an important asset in future studies of teachers' practices.

Second, as shown here, the role of adaptation in the implementation of reform is clearly complex. On the one hand, mathematics education reformers agree that mathematics teaching requires a degree of improvisation and adaptation on the part of teachers. Yet, reformers also want teachers to be faithful to the goals of reform-based curricula. Our research suggests that unraveling this dilemma involves exploring in detail the types of adaptations teachers tend to make, the reasons behind those adaptations, and when in the planning and instructional process such adaptations occur. Further, different patterns, or models, of use and adaptation most likely have different potential for the kinds of mutual adaptation (McLaughlin, 1976) of both curriculum and practice believed to lead to the success of reform.

Third, how and why teachers use reform curricula in the ways they do has clear implications for potential of curriculum as a large-scale vehicle for teacher learning and mathematics education reform. Specifically, we believe that this study provides important implications for the design of reform-based curricula. We want to emphasize that this research took place in the context of the development of the CMW curriculum, undertaken so that teachers' needs could be addressed by revisions of the curriculum. In particular, it seems critical for developers of reform-based curricula to be explicit about the conceptual goals and intentions of a given lesson or set

of lessons and to connect those goals directly to the proposed activities. At a deeper level, curriculum materials might need to connect to the lived mathematics experiences of teachers, and support teachers in reflecting on and perhaps reconstructing their narrative mathematics identities as they consider the roles of reform and of reform-oriented curriculum materials in their narratives. This kind of support was available to Beth and Linda as a result of their participation in this professional development and research, but must become part of the curriculum in order to facilitate teacher learning on a larger scale.

It is interesting to note that, in some cases, Beth and Linda were quite explicit about linking their mathematics stories to their mathematics practices, while in other cases they seemed unaware of the possible connections. One route that we have begun to explore in both pre-service and in-service teacher education is making teachers more aware of their mathematics stories and, as a result, of the potential impact of these experiences on teachers' practices and understandings (LoPresto & Drake, 2005). Another possibility for future research involves collecting teachers' narrative mathematics identities using alternate methodologies. As stated earlier, we chose a structured interview protocol for obtaining teachers' mathematics stories. It would be interesting to explore the kinds of mathematics stories teachers might tell using a more unstructured methodology and to investigate how these alternative stories helped us to understand teachers' reform implementation practices. Furthermore, a number of factors, underexplored in this study, clearly affect the linkage between teachers' narrative identities and their classroom practices, including the school and classroom culture, language issues (particularly in the bilingual classroom), and perhaps most intriguingly, the developing mathematics stories of the children in the teachers' classrooms. In closing, it is clear that different teachers have different models of curriculum use and patterns of adaptation that can be understood, at least in part, through the lens of teachers' identities as learners and teachers of mathematics. However, a great deal more work remains to be done in exploring the connections between stories and practice.

NOTES

1. We acknowledge that the term "reform curriculum" has many definitions, often at odds with one another. Here, we are referring generally to the curricular materials developed in the United States in the 1990s, primarily in response to the call by the National Council of Teachers of Mathematics (NCTM), among others, for refocusing elementary mathematics instruction to include more problem-solving and critical-thinking skills and greater attention to children's conceptual understanding of mathematics. In particular, this study examined teachers' use of one of these new curricula, Children's Math Worlds.

2. The names of both teachers, as well as the name of their school, are pseudonyms.

3. For Beth, Year 1 and Year 2 models of curriculum use were developed. In this paper, the focus is primarily on her Year 2 model.

4. For Beth, only Year 2 adaptations were identified and coded.

5. Mr. Green's method is a CMW name for a numerical solution method similar to the traditional algorithm except that all of the regrouping is done before any subtracting.

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